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## (54) Producing image data representing a picture

Verfahren zur Erzeugung von Bilddaten

Procédé pour produir des données d'image représentant une image

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**EP-A- 0 100 097**
**EP-A- 0 232 004**

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## Description

**[0001]** This invention relates to apparatus and methods for producing image data representing a picture. An embodiment of the invention described hereinbelow seeks to provide such a method and apparatus for producing image data capable of producing realistic images simulating three-dimensional physical effects. Embodiments of the invention are particularly (but not exclusively) useful for producing such image data in computer graphics applications wherein hardware resources are limited, for example in the case of video game apparatus and computer graphic apparatus.

**[0002]** In certain previously proposed video game apparatus, two-dimensional picture data are mapped to a rectangular picture area (referred to herein as a "sprite"). In such apparatus, the sprites are combined like the tiles of a mosaic on a display screen to produce an image. Such video game apparatus are referred to as two-dimensional or "2D" systems. In such 2D systems, images can only be produced as combinations of two-dimensional images produced from sprite patterns which have been stored in advance and which must be displayed as images lying in a fixed plane.

**[0003]** Other previously proposed apparatus include three-dimensional or "3D" graphic systems such as computer graphic apparatus for producing an image on a two-dimensional screen of a display in such a manner that the image simulates three-dimensional effects. In such 3D systems, the surface of a 3D object to be represented is separated into a plurality of polygonal surfaces having various arbitrary shapes. Picture data representing the polygonal areas of the 3D object are successively stored in a frame memory having memory locations corresponding to positions on a display screen to accumulate picture data which, when supplied to the display, reconstruct an image which appears to be three-dimensional.

**[0004]** In such 3D systems the data representing each of the polygonal surfaces must be transformed in order to represent three-dimensional effects such as rotation of the object they represent. This function would be very difficult to realize in a 2D system since it would be necessary to carry out complex address calculations to map texture data to each transformed polygonal surface.

**[0005]** 2D systems achieve image movement by rearranging sprite patterns within a plane representing the display screen, which is a relatively easy function to implement. However, such a function would be very difficult to carry out in a 3D system for the following reasons.

**[0006]** The previous 3D systems do not assemble data for a display screen as an aggregate of sprites. To produce a 3D image from an aggregate of sprites by effecting a modification to such a 3D system, it would be necessary to map a texture pattern stored in a texture pattern area of a memory (such as a video memory or frame buffer) to a three-dimensionally transformed polygonal surface. It will be appreciated that the picture data producing or "drawing" instructions consequently would be complicated.

**[0007]** In 3D systems the image data for the various polygonal surfaces are produced in succession based on data indicating the depth of each polygonal surface from the plane of the display screen. If it were desired to represent an arbitrary shape on a background using data arranged as sprites, it would be necessary to represent the overlapped portions of the background as transparent. Previous 3D systems produce image data representing the polygonal surfaces of an object such that surfaces which cannot be seen from the point of view when displayed are produced first and stored in a display memory and the remaining data representing the polygonal surfaces are successively produced in order according to their depth from the screen. Consequently, image data representing a polygonal surface at the front of the object cover over the image data of reverse surfaces which previously were produced and stored. It is necessary, therefore, to include data indicating the depth of each polygonal surface (referred to as "Z data") and the order in which the data representing the polygons are produced is determined by reference to such Z data.

**[0008]** In the previous 3D systems a Z buffer is provided to store the Z data in pixel units and the stored Z data are compared to determine a display preference. While it may appear promising to determine which sprites will be transparent by means of comparing the stored Z data, since the Z data are required for each pixel, the Z buffer must have a very large capacity.

**[0009]** In order to produce image data representing an arbitrarily shaped area (such as a circular area), this is carried out by means of a masking function which renders image data transparent on a pixel-by-pixel basis. To carry this function out, masking data, termed an "$\alpha$ plane", are required in addition to texture image data representing image features to be mapped to a predefined surface. In order to display a sprite in an overlapping relationship with a polygonal surface produced by a 3D system, such mask data are required in order to mask the portion of the polygonal area overlapped by the sprite.

**[0010]** In systems which utilize a sprite function in a previously proposed 3D system, a memory having a large capacity and a number of circuits for use exclusively in producing the 3D data are required. It will be appreciated that such a system is extraordinarily large and complex as compared with a 2D system.

**[0011]** It has also been proposed to implement a system wherein 2D image data would be produced by means of a previously proposed 2D system and three-dimensional image data would be produced by means of a previously proposed 3D system independently of the 2D system. The 2D image data and the 3D image data which have been produced independently would then be added upon conversion into a video signal to be supplied to a video display device.

**[0012]** A drawback of such a system is that circuitry, including separate frame memories, are required for producing the 2D image data and the 3D image data. Moreover, it is difficult to mix separately produced polygonal image data and sprite image data in order to produce a combined image.

**[0013]** European Patent Application Publication No. EP-A-0 309 373 discloses a method and apparatus for producing image data in which sprite producing instructions are used to produce a sprite in the form of a graphic object shown on a display. The sprite can be hidden, shown, redefined, placed or moved.

**[0014]** Another sprite display technique is disclosed in US Patent No. US-A-4 951 038.

**[0015]** EP-A-0 100 097 discloses a digital image processing system in the form of a flight simulator. The system has a data base with a digital 3D coordinate system and a library of 2D image frames, and scene composition data which defines locations and sizes of the image frames. Data from the data base is used to compose a simulated visual display for an observer in the cockpit of an aircraft. More specifically, EP-A-0 100 097 discloses a computer controlled imaging system which combines the advantages of computer synthezised and computer generated imagery. The system constructs sequences of scenes of true realism in placing computer synthesized 2D or 3D objects of an object library on a surface or background image. EP-A-0 100 097 achieves real-time processing without relying on sprite producing instructions generally used for graphics animation.

**[0016]** According to a first aspect of the present invention there is provided a method for producing image data representing a picture, the method comprising the step of producing sprite producing instructions representative of two dimensional image data, in which each of said sprite producing instructions includes a sprite data portion and a sprite tag portion representative of an address location; producing, based on first polygon producing instructions representative of three-dimensional image data, second polygon producing instructions representative of two-dimensional image data, each of said second polygon producing instructions including a polygon data portion and a polygon tag portion representative of an address location; performing a sorting operation, based on the address locations represented by the tag portions of the sprite producing instructions and the second polygon producing instructions, to determine a mixed sequence of said sprite and second polygon producing instuctions, said sequence defining an order for executing said sprite producing instructions and said second polygon producing instructions; producing image data by executing the sprite producing instructions and the second polygon producing instructions in said determined order, the image data including a plurality of pixels each having a corresponding image location; and storing the plurality of pixels of the produced image data in a memory such that a pixel produced after another pixel having a corresponding image location overwrites the other pixel.

**[0017]** According to a second aspect of the present invention there is provided an apparatus for producing image data representing a picture, said apparatus comprising means for producing sprite producing instructions representative of two dimensional data, in which each of said sprite producing instructions includes a sprite data portion and a sprite tag portion representative of an address portion; means for producing, based on first polygon producing instructions representative of three-dimensional image data, second polygon producing instructions representative of two-dimensional image data, each of said second polygon producing instructions including a polygon data portion and a polygon tag portion representative of an address location; means for performing a sorting operation, based on the address locations represented by the tag portions of the sprite producing instructions and the second polygon producing instructions, to determine a mixed sequence of said sprite and second polygon producing instuctions, said sequence defining an order for executing said sprite producing instructions and said second polygon producing instructions; image data producing means for producing image data by executing the sprite producing instructions and the second polygon producing instructions in said determined order, the image data including a plurality of pixels each having a corresponding image location; and first memory means for storing the plurality of pixels of the produced image data such that a pixel produced after another pixel having a corresponding image location overwrites the other pixel.

**[0018]** According to a third aspect of the present invention there is provided a circuit comprising: an apparatus as set forth above; a main bus; input means coupled with the main bus for receiving the sprite producing instructions and the first polygon producing instructions and providing the received instructions to the main bus; a main memory coupled with the main bus and operative to receive therefrom, store and read out the sprite producing instructions and the first polygon producing instructions; said means for producing the second polygon producing instructions being coupled with the main bus to receive the first polygon producing instructions; said sorting means being coupled with the main bus to supply the sprite producing and second polygon producing instructions to the main memory for storage therein; the image data producing means being coupled with the main bus; and a memory controller for transferring the sprite producing instructions to the image data producing means via the main bus; said first memory means comprising frame memory means for storing the image data produced by the image data producing means.

**[0019]** According to a fourth aspect of the invention there is provided a game playing apparatus for producing game image data representing a game image based on sprite producing instructions for producing two-dimensional image data and polygon producing instructions for producing three-dimensional image data, the

game playing apparatus comprising apparatus as set forth above, wherein: game user input means is operable to produce game operation commands in response to an action by a user; said means for producing the second polygon producing instructions is operable based upon the game operation commands; said image data producing means is operable to produce the game image data; and said first memory means is operable to store the plurality of pixels of the produced game image data and to output the stored pixels for producing the game image.

**[0020]** An embodiment of the invention described hereinbelow implements the functions of a 2D system as well as those of a 3D system by means of a common apparatus which requires the use of only a single image memory. Consequently, efficient use of the required hardware is achieved. Moreover, the image data producing functions of a 3D system and the sprite image data producing function of a 2D system are integrated by means of the method and apparatus of the embodiment of the invention simply by assigning priorities to the respective image data producing instructions so that the functions of the 3D system and those of the 2D system are easily implemented and image data for producing display images with numerous variations can be obtained easily and inexpensively.

**[0021]** The embodiment of the invention described hereinbelow provides:

methods and apparatus which alleviate or overcome the above disadvantages and shortcomings of the above-described prior proposals;
methods and apparatus for producing picture data employing features of both 2D systems and 3D systems by means of a common picture data producing apparatus and employing a common image memory; and
apparatus and methods for producing picture data which employ relatively simple and inexpensive hardware and which nevertheless produce picture data which may be used to provide realistic display images.

**[0022]** The invention will now be further described, by way of illustrative and non-limiting example, with reference to the accompanying drawings, in which corresponding parts and components are identified by the same reference numerals in the several figures, and in which:

Fig. 1 is a block diagram of a game playing apparatus in accordance with an embodiment of the invention;
Fig. 2 is a flow chart for use in illustrating a process of producing polygon surface image data with the use of the embodiment of Fig. 1;
Fig. 3 is a schematic diagram illustrating a memory space of a frame memory of the Fig. 1 embodiment;
Figs. 4A to 4C illustrate a technique for mapping texture data onto polygonal surface image areas;
Figs. 5A and 5B illustrate the structure of a polygon producing instruction as employed in the embodiment of Fig. 1;
Fig. 6 schematically illustrates a manner in which the polygon producing instructions of Figs. 5A and 5B are executed in succession according to tags included therewith;
Fig. 7 illustrates the data structure of a sprite image data producing instruction;
Fig. 8 schematically illustrate a process of mapping texture image data stored in a texture area of the frame memory of the Fig. 1 embodiment onto a sprite image area in a picture drawing area of the frame memory;
Fig. 9 schematically illustrates a sprite producing instruction string;
Figs. 10A and 10B illustrate a technique far producing an arbitrarily selected shape with the use of a sprite producing instruction;
Fig. 11 is a color conversion table to which reference is made in describing the technique of Figs. 10A and 10B; and
Fig. 12 schematically illustrates a technique for inserting a sprite producing instruction string in a polygon producing instruction string in order to produce image data by freely mixing polygon producing instructions and sprite producing instructions.

**[0023]** With reference first to Fig. 1, a block diagram of a game playing apparatus in accordance with an embodiment of the present invention is illustrated therein. As seen in Fig. 1, a system bus 1 is coupled with a central processing unit (CPU) 2, as well as to a main memory 3, an image data decompressor 4, a CD-ROM decoder 5, an image data producing apparatus 6, a direct memory access (DMA) controller 7 and a user command input device 30.

**[0024]** The CD-ROM decoder 5 is coupled with a CD-ROM driver 9 which serves to read data from a CD-ROM 20 loaded in the CD-ROM driver 9. The data read from the CD-ROM 20 includes an application program having two-dimensional image data producing instructions such as sprite picture drawing instructions as well as three-dimensional image data producing instructions such as polygonal surface image data producing instructions (sometimes referred to herein as "polygon producing instructions"). The data read from the CD-ROM 20 also includes texture image data such as still image data and moving picture image data to be mapped on a sprite or polygonal image surface. In addition, data representing a color conversion table (CLUT) are read from the CD-ROM 20 by the CD-ROM driver 9. The data read from the CD-ROM 20 are supplied by the CD-ROM driver 9 to the CD-ROM decoder 5 which decodes the read-out data and supplies the decoded data to the system bus 1.

**[0025]** The two- and three-dimensional image data producing instructions are transferred from the CD-ROM decoder 5 to the main memory 3 for storage therein by the DMA controller 7.

**[0026]** The user command input device 30 may be, for example, a keyboard or joystick-type input device, or any other suitable means for translating actions of a game user into commands which may be recognized by the game playing apparatus. The CPU 2 (which may be, for example, a 32 bit CPU) receives game operation commands from the user command input device 30 and determines the motion of an object or objects within the image to be produced, or a shift of the viewpoint of such image in response to the commands input with the use of the device 30. The CPU 2 also obtains the three-dimensional image data producing instructions from the main memory 3 and provides the same to a coordinate conversion apparatus 8 coupled by a pipeline connection to the CPU 2. In further embodiments, the coordinate, conversion apparatus is connected directly to the main bus 1.

**[0027]** Based on the determinations of object motion and/or changes in viewpoint as determined by the CPU 2, the coordinate conversion apparatus 8 carries out three-dimensional coordinate conversion of the three-dimensional image data producing instructions to reflect the consequent translation and rotation of the three-dimensional images to be produced by means of these instructions. The apparatus 8 also converts the three-dimensional image data producing instructions as thus modified into converted two-dimensional image data producing instructions for producing two-dimensional image data. The CPU 2 produces polygon producing instruction strings based on the above-mentioned determinations of object motion and viewpoint shifts. The instructions are stored in the main memory 3.

**[0028]** As mentioned above, texture data are also read from the CD-ROM 20 and decoded by the CD-ROM decoder 5. Where the texture data is moving picture data, it is typically recorded in compressed form on the CD-ROM 20, for example, by discrete cosine transformation (DCT). The decoded texture data is supplied by the CD-ROM decoder 5 to the main bus 1 from which the decoded texture data are obtained by the main memory 3 and stored therein. Subsequently, the compressed texture data are supplied via the main bus 1 to the image decompressor 4 which carrion out inverse discrete cosine transformation of the compressed texture data to produce decompressed texture data 3.

**[0029]** The image data producing apparatus 6 is connected to a frame memory 10 by way of a local bus 11. The frame memory 10 includes two frame memories, each of which has a picture drawing memory area. At any given time, one frame memory is used to produce and store image data while image data is read from the second frame memory to produce a display image. The roles of the respective frame memories are switched at each vertical interval.

**[0030]** The frame memory 10 has a texture area for storing texture data which are transferred thereto either from the main memory 3 or from the image data decompressor 4 after decompression, if need be, to be stored far use in producing the image data. Also, the frame memory 10 stores the color conversion table data CLUT in a color look-up table after the data are transferred from the CD-ROM decoder 5 to the frame memory 10 by the DMA controller 7.

**[0031]** The image data are output from the frame memory 10 by the image data producing apparatus 6 to a D/A converter 12 to be converted to analog form for display by an image display monitor 13.

**[0032]** The two-dimensional image data producing instructions and the converted two-dimensional image data producing instructions (that is, those produced by converting the three-dimensional image data producing instructions in the coordinate conversion apparatus 8) are transferred by the DMA controller 7 to the image data producing apparatus 6 in an order determined according to a sorting operation carried out by the CPU 2, as described below. The apparatus 6 executes the instructions as received from the main memory 3 and writes display data produced with the use of these instructions into the picture drawing area of that one of the frame memories currently used to produce image data.

**[0033]** The image data producing apparatus 6 is provided with a slope calculation unit (not shown for purposes of simplicity and clarity) which serves to carry out a slope determination for the purpose of converting data to be mapped onto a polygonal image surface produced with the use of the instructions received from the vain memory 3. The data to be napped onto the polygonal image surface, as well as that which may be mapped onto a sprite area, may be either texture data or data representing light shading (in which case the polygonal image surface or sprite is filled with brightness values).

**[0034]** With reference also to Fig. 2, a flow chart is provided therein for illustrating the operation of producing two-dimensional image data of a polygonal image surface based on a three-dimensional image data producing instruction. In a step 101, the CPU 2 transfers an instruction stored in the main memory 3 to the coordinate conversion apparatus 8 by way of the system 'bus 1. Based on commands input by a user with the use of the device 30, the coordinate conversion apparatus 8 in a step 102 carries out three-dimensional coordinate conversion of a polygon producing instruction to effect appropriate rotation and translation of a corresponding three-dimensional object to be depicted with the use of data produced by the polygon producing instruction. The instruction as thus modified is then converted to a two-dimensional image data producing instruction in a step 103. When the three-dimensional instructions have been thus converted, they are sorted by the CPU 2 by a process described below as indicated by the step 104 and transferred to the main memory 3 for storage therein by way of the system bus 1.

**[0035]** As indicated above, the instructions as sorted by the CPU 2 are transferred in sequence from the main memory 3 to the image data producing apparatus 6 by the DMA controller 7 via the system bus 1. Once the instructions have been carried out, as mentioned above, the above-described slope determination is performed by the image data producing apparatus 6, as indicated by a step 105, and texture or brightness data is mapped to the produced polygonal surfaces in order to "draw" polygonal image surface data and store the same in the frame memory, as indicated by step 106. Subsequently, in a step 107 once all of the image data, including polygonal image surface data, have been thus produced and stored, after the next vertical interval the data are output to produce a display.

**[0036]** As mentioned above, the frame memory 10 has a texture area for storing texture data and a picture drawing area for storing image data as a frame of an image is produced. With reference now to Fig. 3, a memory space of the frame memory 10 is illustrated schematically wherein memory locations are arranged according to column and row addresses so that the data are stored according to two-dimensional data addresses. The memory apace of the frame memory 10 includes a two-dimensional address texture area AT for storing the texture data. A number of different kinds of texture patterns can be stored in the area AT.

Reference AD designates the picture drawing area of the memory space, as mentioned above. Finally, reference character AC designates a memory area in which the color conversion table CLUT is stored.

**[0037]** With reference now to Figs. 4A to 4C, a technique for mapping texture data to polygonal image surfaces is illustrated therein. Referring to Fig. 4A, texture data patterns T1, T2 and T3 stored in the texture data area AT are subjected to two-dimensional mapping conversion to map the texture data onto a respective polygonal image surface defining a corresponding face of an object OB1 as illustrated in Fig. 4B. Once the mapping conversion has been carried out, each of the converted texture patterns T1, T2 and T3 is stored in the picture drawing area AD to conform to its respective polygonal image surface on the object OB1 as illustrated in Fig. 4C. Subsequently, the data are read out from the area AD to produce an image display.

**[0038]** As noted above, the texture data may take the form of still picture data or moving picture data. In the case of still picture data, its texture data is transferred from the main memory 3 to the texture area AT of the frame memory 10 by way of the image data producing apparatus 6. The apparatus 6 maps the texture data to a selected polygonal image surface in accordance with a received instruction so that as a consequence, the still picture data serves to produce an image on the surface of an object corresponding to the polygonal area.

**[0039]** In the case of moving picture texture data, the data as compressed is read from the CD-ROM 20, decoded by the CD-ROM decoder 5 and stored in the main memory 3. Then, the compressed data are supplied to the image data decompressor 4 where the data are decompressed, and the decompressed moving picture data are later stored in the texture area AT of the frame memory 10. The texture pattern itself in the texture area AT can be rewritten for each frame so that the image data mapped to corresponding polygonal image surfaces are automatically updated. In this manner, moving pictures can be mapped onto the surface of an object as displayed.

**[0040]** Images having three-dimensional characteristics can be produced by means of a two-dimensional display by successively producing and storing image data of polygonal image surfaces representing object surfaces in order from those which are represented by their Z data as farthest from the display screen to those which are closest. In contrast to the Z buffer method in which Z data are stored for each pixel in memory, the present embodiment determines the order in which polygonal image surface data are produced and stored in the following manner.

**[0041]** More particularly, as illustrated in Fig. 5A each polygon producing instruction IP, in accordance with the presently described embodiment of the invention, includes a tag TG in addition to drawing data PD. The tag TG of a given instruction IP represents the address in the main memory 3 at which a next instruction to be carried out is stored. The picture drawing data PD includes identification data IDP indicating that the instruction IP is a polygon producing instruction, coordinate data (X0, Y0), (X1, Y1), (X2, Y2) and (X3, Y3) for example, if the polygonal surface is bounded by a quadrilateral figure, and color data (R, G, B) when the polygonal surface is to be mapped with data representing one color.

**[0042]** As described above, the CPU 2 assembles various instructions to compose a polygon producing instruction string for producing the image data of a corresponding picture. Thereafter, the CPU 2 rewrites the tags of the instruction string to effect sorting in accordance with Z data for each instruction which serves to establish priority far display among polygonal image surface data which have the same or overlapping image positions.

**[0043]** Once these operations are completed, the DMA controller 7 transfers the instructions of the string in succession according to their tags to the image data producing apparatus 6. With reference to Fig. 6, if a first one of the instructions transmitted to the apparatus 6 is identified as IP1 having a tag TG1, the next transmitted instruction, identified as IP2, is that stored at the memory location of main memory 3 indicated by TG1. In the same manner, instructions IP3, IP4, ...are transmitted in succession to the apparatus 6 which produces picture data in accordance with each instruction and stores the picture data in the order as so produced in the picture drawing area AD of the frame memory 10. In this manner, pixel data so produced by the apparatus 6 corresponding in position within a given frame to previously

produced and stored pixel data overwrites the previously stored pixel data.

**[0044]** As noted above the frame memory 10 includes two frame buffers, one of which at a given time is used to assemble a frame of a picture as described above while a frame previously stored in the other frame buffer is read out via the D/A converter 12 to the monitor 13 for producing a corresponding picture display. After a new frame has been assembled in the first frame buffer as described above, the data in the first buffer is read out to produce a display of a new frame while yet another frame is assembled in the second buffer. This process is repeated over and over, typically 30 to 60 tines per second, in order to produce a display of a moving picture.

**[0045]** As noted above, two-dimensional picture drawing instructions serve to produce sprites, rectangular picture data areas which are seen to be within the plane of the picture or parallel thereto. In the present embodiment sprites are produced as rectangular areas of standard dimensions to which texture image data of the same size and shape are mapped. The sprite data drawing or producing instructions may, therefore, be simplified as compared with the polygon producing instructions.

**[0046]** More specifically, and with reference to Fig. 7, a sprite picture drawing instruction as illustrated therein according to the presently described embodiment of the invention includes a tag TG like that of the polygon producing instructions. The sprite drawing instruction also includes sprite picture drawing data SD comprising identification data IDS identifying the instruction as a sprite drawing instruction, coordinate data (X,Y) of a point Ps in the picture drawing area AD of the frame memory 10, and coordinate data (u, v) identifying a position within the texture data space AT of the frame memory 10.

**[0047]** As illustrated by Fig. 8, the sprite picture data drawing instruction of Fig. 7 instructs that picture data be produced for a rectangular picture area which is eight pixels high by eight pixels wide and is located within the picture drawing area AD of the frame memory 10 such that its upper left corner coincides with the point Ps, a point corresponding with a point on the screen of the display screen of the monitor 13 (or whatever device is used to produce a display of the picture). The image content of the eight-by-eight pixel region identified by coordinates (u, v) is specified as the image data within an eight-by-eight pixel region within the texture data space AT of the frame memory 10 beginning at the coordinates (u, v). It is noted that the texture data space AT in memory 10 is arranged as a plurality of pages or sheets each including 256 by 256 pixels. Accordingly, the coordinates (u, v) do not specify an address within the texture data space AT, but rather a rectangular array of pixels (8 x 8) within a respective page thereof.

**[0048]** Referring now to Fig. 9, a sprite picture drawing instruction string can be formed to achieve a picture drawing function similar to the sprite function of a 2D system, but which is also quite similar to the polygon producing instruction strings described hereinabove, in the following manner. Each of a plurality of sprite picture drawing instructions as illustrated schematically in Fig. 9 includes sprite picture drawing data S1 to Sn and a respective tag TGS1 to TGSn each of which, like the tags used in the case of the polygon producing instructions indicates the location in memory of the next sprite picture drawing instruction of the string.

**[0049]** Although each sprite picture drawing instruction produces image data for a rectangular picture area of predetermined dimensions, it is nevertheless possible to represent an object or figure having an arbitrarily selected shape by including transparency as a selectible "color" for the texture data of the sprite. Fig. 10A provides an illustration of the manner in which a circular object can be depicted by a sprite by assigning a color code (in this example "0") to transparency and assigning this code to those portions of the sprite which are not included within the circular figure so that image data which otherwise would be overwritten by the transparent portions of the sprite is nevertheless retained in the frame memory 10.

**[0050]** An exemplary color conversion table CLUT stored in the main memory 3 is illustrated in Fig. 11 wherein a color code or number index is assigned to each possible combination of red (R), green (G) and blue (B) color components to be assigned to a given pixel. In this example, the color number index "0" signifies transparency, that is, that the background is to be displayed as is despite the overlapping portion of the sprite which has been color coded for transparency. Typically a color code which is seldom used (for example, black) is selected to represent transparency.

**[0051]** Referring to Fig. 10B, color codes from the table of Fig. 11 are assigned to each of the 64 pixels of the sprite image area of Fig. 10A in order to depict the desired circular figure. As will be seen from Fig. 10B, the pixels in the corner regions of the sprite have been assigned transparency codes so that image data written previously in the frame memory 10 at corresponding locations are retained due to the transparency codes of those particular sprite pixels. Accordingly, a wide range of arbitrarily selected images may be depicted in this manner even though the dimensions of each sprite are fixed.

**[0052]** It will be appreciated that sprite picture drawing instructions are relatively uncomplicated since texture image data is readily mapped to the sprite image areas of predetermined dimensions. It is relatively easy, therefore, to implement the display of an animated or other moving picture by means of the sprite function. As an example, in thin manner an animation may be displayed in an overlapping relationship with an actually photographed moving picture.

**[0053]** As noted above, the data and list construction of the sprite picture drawing instruction string are similar

to those of the polygon area picture drawing instruction string. Consequently, a sprite drawing instruction string can be inserted freely into a polygonal picture drawing instruction string utilizing the tags of the sprite picture drawing instructions. As an example, and with reference to Fig. 12, a polygonal area picture drawing instruction string includes instructions N - 1, N, N + 1, ..., while a sprite picture drawing instruction string includes instructions S1, S2...Sn which have been prepared separately from the polygon instruction string. The sprite instruction string may be readily inserted into the polygon instruction string, for example, between instructions N and N + 1 in Fig. 12 by rewriting the tag $TG_N$ of the polygon instruction N to identify the location in the memory 3 at which the first sprite instruction S1 of the sprite instruction string is stored. Also, the tag TGSn of the last instruction of the sprite instruction string is rewritten to specify the location in memory 3 where the polygon instruction N + 1 is stored. Consequently, the picture data drawing apparatus 6 will carry out the sprite instruction string after the polygon instruction N and thereafter continue carrying out the polygon instruction string with the polygon instruction N + 1.

**[0054]** It will be seen from the foregoing that polygon drawing instructions and sprite drawing instructions may be freely mixed in this fashion, so that programming for producing a desired picture utilizing both sprite drawing instructions and polygon producing instructions is greatly facilitated.

**[0055]** In the embodiments described hereinabove, instructions and image data were obtained by the apparatus from a CD-ROM. However, other recording media may be employed for this purpose such as, for example, magnetic disks and semiconductor memories (such as memory cards), and other sources for such instructions and data may be employed.

**[0056]** Although specific embodiments of the invention have been described in detail herein with reference to the accompanying drawings, it is to be understood that the invention is not limited to those precise embodiments, and that various changes and modifications may be effected therein by one skilled in the art without departing from the scope of the invention.

## Claims

1. A method for producing image data representing a picture, the method comprising the steps of

   producing (2) sprite producing instructions representative of two dimensional image data, in which each of said sprite producing instructions includes a sprite data portion (SD) and a sprite tag portion (TG) representative of an address location;
   producing (2,8), based on first polygon producing instructions representative of three-dimensional image data, second polygon producing instructions representative of two-dimensional image data, each of said second polygon producing instructions including a polygon data portion and a polygon tag portion representative of an address location;
   performing (2) a sorting operation (104), based on the address locations represented by the tag portions of the sprite producing instructions and the second polygon producing instructions, to determine a mixed sequence of said sprite and second polygon instuctions, said sequence defining, an order for executing said sprite producing instructions and said second polygon producing instructions;
   producing (6) image data by executing the sprite producing instructions and the second polygon producing instructions in said determined order, the image data including a plurality of pixels each having a corresponding image location; and
   storing (10) the plurality of pixels of the produced image data in a memory such that a pixel produced after another pixel having a corresponding image location overwrites the other pixel.

2. The method of claim 1, wherein the address location of each of the sprite producing instructions and the second polygon producing instructions represents a memory address of a next one of the instructions to be executed.

3. The method of claim 1, wherein Z-data are used for setting the address locations of the second polygon producing instructions, said Z-data corresponding to depths of respective surfaces represented by the produced image data.

4. The method of claim 1, further comprising the step of modifying the second polygon producing instructions in accordance with movement of an image to be produced with the use of the second polygon producing instructions and a change in a point of view of the image to be produced.

5. The method of claim 4, wherein the step of modifying the second polygon producing instructions comprises determining said movement of said image and said change in said point of view based on a command produced in response to operation of a game input device (30).

6. The method of claim 1, wherein the step of producing image data comprises generating image surfaces and mapping image texture data to the generated image surfaces to produce said pixels.

7. The method of claim 6, further comprising the step of reading the sprite and first polygon producing instructions from a memory (20), reading compressed texture data from the memory and decompressing (4) the compressed texture data to produce the image texture data.

8. The method of claim 7, wherein the memory (20) is a CD-ROM.

9. The method of claim 1, further comprising the steps of forming a sprite producing instruction string from a number of said sprite producing instructions, forming a polygon producing instruction string from a number of said second polygon producing instructions, and inserting one of said sprite producing instruction string and said polygon producing instruction string into the other of said sprite producing instruction string and said polygon producing instruction string at a desired location thereof.

10. The method of claim 1, wherein the sprite data portion of each of the sprite producing instructions includes identification data indicating that the instruction is a sprite producing instruction, and the polygon data portion of each of the second polygon producing instructions includes identification data indicating that the instruction is a polygon producing instruction.

11. An apparatus for producing image data representing a picture, said apparatus comprising

means (2) for producing sprite producing instructions representative of two dimensional data, in which each of said sprite producing instructions includes a sprite data portion (SD) and a sprite tag portion (TG) representative of an address portion;
means (2,8) for producing, based on first polygon producing instructions representative of three-dimensional image data, second polygon producing instructions representative of two-dimensional image data, each of said second polygon producing instructions including a polygon data portion and a polygon tag portion representative of an address location;
means (2) for performing a sorting operation (104), based on the address locations represented by the tag portions of the sprite producing instructions and the second polygon producing instructions, to determine a mixed sequence of said sprite and second polygon instuctions, said sequence defining an order for executing said sprite producing instructions and said second polygon producing instructions;
image data producing means (6) for producing image data by executing the sprite producing instructions and the second polygon producing instructions in said determined order, the image data including a plurality of pixels each having a corresponding image location; and
first memory means (10) for storing the plurality of pixels of the produced image data such that a pixel produced after another pixel having a corresponding image location overwrites the other pixel.

12. The apparatus of claim 11, further comprising second memory means (3), wherein the address location of each of the sprite producing instructions and the second polygon producing instructions represents an address in the second memory means of a next one of the instructions to be executed.

13. The apparatus of claim 12, wherein Z-data are used for setting the address locations of the second polygon producing instructions, said Z-data corresponding to depths of respective surfaces represented by the produced image data.

14. The apparatus of claim 11, further comprising modifying means for modifying the second polygon producing instructions in accordance with movement of an image to be produced with the use of the second polygon producing instructions and a change in a point of view of the image to be produced.

15. The apparatus of claim 14, wherein the modifying means is operative to determine said movement of said image and said change in said point of view based on a command produced in response to operation of a game input device (30).

16. The apparatus of claim 11, wherein the image data producing means (6) is operative to generate image surfaces and to map image texture data to the generated image surfaces to produce said pixels.

17. The apparatus of claim 11, wherein the first memory means (10) includes first and second frame buffers and is operative during a first vertical interval of the image data to store pixels successively produced by the image data producing means and simultaneously to read previously produced pixels from the second frame buffer for producing a display image, and is operative during a successive vertical interval of the image data to write data produced by the image data producing means in the second frame buffer and simultaneously to read previously produced pixels from the first frame buffer for producing a second picture display.

18. The apparatus of claim 16, wherein the image data producing means (6) is operative to produce data

representing rectangular image areas parallel to a plane of the picture by executing the sprite producing instructions.

**19.** The apparatus of claim 18, wherein the first memory means (10) is operative to store the image texture data for use by the image data producing means.

**20.** The apparatus of claim 18, wherein the first memory means (10) is operative to store a color conversion table including a code representing transparency and to read data from the color conversion table to the image data producing means, and wherein the image data producing means (6) is operative to utilize data from said color conversion table to assign colors to pixels within said rectangular image areas and in response to said code representing transparency to refrain from overwriting pixel data in corresponding locations previously stored in the first memory means.

**21.** The apparatus of claim 11, further comprising means for forming a sprite producing instruction string from a number of said sprite producing instructions, for forming a polygon producing instruction string from a number of said second polygon producing instructions, and for inserting one of said sprite producing instruction string and said polygon producing instruction string into the other of said sprite producing instruction string and said polygon producing instruction string at a desired location thereof.

**22.** The apparatus of claim 11, wherein the sprite data portion of each of the sprite producing instructions includes identification data indicating that the instruction is a sprite producing instruction, and the polygon data portion of each of the second polygon producing instructions includes identification data indicating that the instruction is a polygon producing instruction.

**23.** The apparatus of claim 11, further comprising second memory means (3) for storing the sprite producing instructions and the second polygon producing instructions, and means (7) for transferring the instructions stored in the second memory means to the image data producing means (6) in said determined order.

**24.** A circuit comprising:

an apparatus according to claim 11;
a main bus (1);
input means (5, 9) coupled with the main bus (1) for receiving the sprite producing instructions and the first polygon producing instructions and providing the received instructions to the main bus;
a main memory (3) coupled with the main bus (1) and operative to receive therefrom, store and read out the sprite producing instructions and the first polygon producing instructions;
said means (2,8) for producing the second polygon producing instructions being coupled with the main bus (1) to receive the first polygon producing instructions;
said sorting means (2) being coupled with the main bus to supply the sprite producing and second polygon producing instructions to the main memory for storage therein;
the image data producing means (6) being coupled with the main bus; and
a memory controller (7) for transferring the sprite producing instructions to the image data producing means (6) via the main bus (1);
said first memory means comprising frame memory means (10) for storing the image data produced by the image data producing means (6).

**25.** The circuit of claim 24, wherein the input means (5, 9) is operative to receive compressed image texture data and to supply the compressed image texture data to the main bus (1), the main memory (3) is operative to receive from the main bus, store and read out the compressed image texture data, the circuit further comprises an image data decompressor (4) coupled with the main bus to receive the compressed image texture data read out from the main memory, the image data decompressor being operative to decompress the compressed image texture data and supply decompressed image texture data to the main bus, the frame memory means (10) is operative to store the decompressed image texture data in a texture area thereof, and the image data producing means (6) is operative to produce the image data utilizing the decompressed image texture data stored in the frame memory means.

**26.** The circuit of claim 25, wherein the input means (5, 9) comprises a decoder (5) having an input to receive the compressed image texture data, the sprite producing instructions and the first polygon producing instructions in encoded form and operative to decode the received encoded compressed image texture data, sprite producing instructions and first polygon producing instructions.

**27.** The circuit of claim 26, wherein the decoder (5) comprises a CD-ROM decoder, and wherein the input means further comprises a CD-ROM drive (9) for reading the encoded compressed image texture data, sprite producing instructions and first polygon producing instructions therefrom and to supply the same to the CD-ROM decoder.

**28.** A game playing apparatus for producing game image data representing a game image based on sprite producing instructions for producing two-dimensional image data and polygon producing instructions for producing three-dimensional image data, the game playing apparatus comprising apparatus according to any one of claims 11 to 23, wherein:

game user input means (30) is operable to produce game operation commands in response to an action by a user;
said means (2,8) for producing the second polygon producing instructions is operable based upon the game operation commands;
said image data producing means (6) is operable to produce the game image data; and
said first memory means (10) is operable to store the plurality of pixels of the produced game image data and to output the stored pixels for producing the game image.

**29.** The game playing apparatus of claim 28, further comprising an A/D converter for converting the pixels output by the first memory means to analog form.

**Patentansprüche**

**1.** Verfahren zum Erzeugen von Bilddaten, die ein Bild darstellen, wobei das Verfahren folgende Schritte aufweist:

Erzeugen (2) von Sprite-Erzeugungsinstruktionen, die zwei dimensionale Bilddaten zeigen, bei denen jede Sprite-Erzeugungsinstruktion einen Sprite-Datenbereich (SD) und einen Sprite-Kennzeichnungsbereich (TG), der eine Adreßlage zeigt, aufweist,
Erzeugen (2, 8) - auf der Basis erster Polygonerzeugungsinstruktionen, die für dreidimensionale Bilddaten repräsentativ sind - von zweiten Polygonerzeugungsinstruktionen, die für zweidimensionale Bilddaten repräsentativ sind, wobei jede der zweiten Polygonerzeugungsinstruktionen einen Polygondatenbereich und einen Polygonkennzeichnungsbereich, der für eine Adreßlage repräsentativ ist, aufweist;
Durchführen (2) eines Sortierbetriebs (104) auf der Basis der Adreßlagen, die durch die Kennzeichnungsbereiche der Sprite-Erzeugungsinstruktionen und der zweiten Polygonerzeugungsinstruktionen dargestellt werden, um eine Mischsequenz der Sprite- und zweiten Polygonerzeugungsinstruktionen zu bestimmen, wobei die Sequenz eine Ordnung zum Ausführen der Sprite-Erzeugungsinstruktionen und der zweiten Polygonerzeugungsinstruktionen festlegt,
Erzeugen (6) von Bilddaten durch Ausführen der Sprite-Erzeugungsinstruktionen und der zweiten Polygonerzeugungsinstruktionen in der vorgegebenen Ordnung, wobei die Bilddaten mehrere Pixel aufweisen, die jeweils eine entsprechende Bildlage aufweisen; und
Speichern (10) der mehreren Pixel der erzeugten Bilddaten in einem Speicher, so daß ein Pixel, welches nach einem anderen Pixel erzeugt wird, welches eine entsprechende Bildlage hat, das andere Pixel überschreibt.

**2.** Verfahren nach Anspruch 1, wobei die Adreßlage jede der Sprite-Erzeugungsinstruktionen und der zweiten Polygonerzeugungsinstruktionen eine Speicheradresse einer nächsten der Instruktionen, die auszuführen ist, erzeugt.

**3.** Verfahren nach Anspruch 1, wobei Z-Daten zum Setzen der Adreßlagen der zweiten Polygonerzeugungsinstruktionen verwendet werden, wobei die Z-Daten der Tiefe der jeweiligen Flächen, die durch die erzeugten Bilddaten dargestellt werden, entspricht.

**4.** Verfahren nach Anspruch 1, welches außerdem den Schritt aufweist, die zweiten Polygonerzeugungsinstruktionen gemäß der Bewegung eines zu erzeugenden Bilds mit der Verwendung der zweiten Polygonerzeugungsinstruktionen und einer Änderung in einem Blickpunkt des Bilds, welches zu erzeugen ist, zu modifizieren.

**5.** Verfahren nach Anspruch 4, wobei der Schritt zum Modifizieren der zweiten Polygonerzeugungsinstruktionen das Bestimmen der Bewegung des Bilds und der Änderung in diesem Blickpunkt auf der Basis eines Befehls umfaßt, der als Antwort auf eine Betätigung einer Spieleingabeeinrichtung (30) erzeugt wird.

**6.** Verfahren nach Anspruch 1, wobei der Schritt zum Erzeugen von Bilddaten das Erzeugen von Bildflächen und das Abbilden von Bildtexturdaten zu den erzeugten Bildflächen umfaßt, um die Pixel zu erzeugen.

**7.** Verfahren nach Anspruch 6, welches außerdem den Schritt aufweist, die Spriteund die ersten Polygonerzeugungsinstruktionen von einem Speicher (20) zu lesen, die komprimierten Texturdaten vom Speicher zu lesen und die komprimierten Texturdaten zu dekomprimieren (4), um die Bildtexturdaten zu erzeugen.

**8.** Verfahren nach Anspruch 7, wobei der Speicher

(20) ein-CD-ROM ist.

**9.** Verfahren nach Anspruch 1, welches außerdem den Schritt aufweist, eine Sprite-Erzeugungsinstruktionsfolge von einer Anzahl von Sprite-Erzeugungsinstruktionen zu bilden, eine Polygonerzeugungsinstruktionsfolge von einer Anzahl der zweiten Polygonerzeugungsinstruktionen zu bilden und ein von Sprite-Erzeugungsinstruktionsfolge und Polygonerzeugungsinstruktionsfolge in die andere von Sprite-Erzeugungsinstruktionsfolge und Polygonerzeugungsinstruktionsfolge in einer gewünschten Lage einzufügen.

**10.** Verfahren nach Anspruch 1, wobei der Sprite-Datenbereich der Sprite-Erzeugungsinstruktionen Identifikationsdaten aufweist, die zeigen, daß die Instruktion eine Sprite-Erzeugungsinstruktion ist, und der Polygondatenbereich der zweiten Polygonerzeugungsinstruktionen Identifikationsdaten aufweist, die zeigen, daß die Instruktion eine Polygonerzeugungsinstruktion ist.

**11.** Gerät zum Erzeugen von Bilddaten, die ein Bild darstellen, wobei das Gerät aufweist:

eine Einrichtung (2) zum Erzeugen von Sprite-Erzeugungsinstruktionen, die für zweidimensionale Daten repräsentativ sind, in denen die Sprite-Erzeugungsinstruktionen einen Sprite-Datenbereich (SD) und einen Sprite-Kennzeichnungsbereich (TG), der für einen Adreßbereich repräsentativ ist, aufweisen;
eine Einrichtung (2, 8) zum Erzeugen auf der Basis erster Polygonerzeugungsinstruktionen, die für dreidimensionalen Bilddaten repräsentativ sind, von zweiten Polygonerzeugungsinstruktionen, die für zweidimensionale Bilddaten repräsentativ sind, wobei die zweiten Polygonerzeugungsinstruktionen einen Polygondatenbereich und einen Polygonkennzeichnungsbereich aufweisen, der für eine Adreßlage repräsentativ ist;
eine Einrichtung (2) zum Durchführen eines Sortierbetriebs (104) auf der Basis der Adreßlagen, die durch die Kennzeichnungsbereiche der Sprite-Erzeugungsinstruktionen und der zweiten Polygonerzeugungsinstruktionen dargestellt werden, um eine Mischsequenz der Sprite- und der zweiten Polygonerzeugungsinstruktionen zu bestimmen, wobei die Sequenz eine Ordnung festlegt, um die Sprite-Erzeugungsinstruktionen und die zweiten Polygonerzeugungsinstruktionen auszuführen;
eine Bilddaten-Erzeugungseinrichtung (6), um Bilddaten durch Ausführen der Sprite-Erzeugungsinstruktionen und der zweiten Polygonerzeugungsinstruktionen in der vorgegebenen Ordnung zu erzeugen, wobei die Bilddaten mehrere Pixel aufweisen, die eine entsprechende Bildlage haben; und
eine erste Speichereinrichtung (10), um die mehreren Pixel der erzeugten Bilddaten zu speichern, so daß ein Pixel, welches nach einem anderen Pixel erzeugt wird, welches eine entsprechende Bildlage aufweist, das andere Pixel überschreibt.

**12.** Gerät nach Anspruch 11, welches außerdem eine zweite Speichereinrichtung (3) aufweist, wo die Adreßlage der Sprite-Erzeugungsinstruktionen und der zweiten Polygonerzeugungsinstruktionen eine Adresse in der zweiten Speichereinrichtung einer nächsten der Instruktionen, die auszuführen ist, zeigt.

**13.** Gerät nach Anspruch 12, wobei Z-Daten zum Setzen der Adreßlagen der zweiten Polygonerzeugungsinstruktionen verwendet werden, wobei die Z-Daten der Tiefe der jeweiligen Flächen, die durch die erzeugten Bilddaten gezeigt werden, entsprechen.

**14.** Gerät nach Anspruch 11, welches außerdem eine Modifikationseinrichtung aufweist, um die zweiten Polygonerzeugungsinstruktionen gemäß der Bewegung eines zu erzeugenden Bilds unter Verwendung der zweiten Polygonerzeugungsinstruktionen und einer Änderung in einem Blickpunkt des zu erzeugenden Bilds zu modifizieren.

**15.** Gerät nach Anspruch 14, wobei die Modifikationseinrichtung die Bewegung des Bilds und die Änderung des Blickpunktes auf der Basis eines Befehls, der als Antwort auf die Betätigung der Spieleingabeeinrichtung (30) erzeugt wird, bestimmt.

**16.** Gerät nach Anspruch 11, wobei die Bilddatenerzeugungseinrichtung (6) Bildflächen erzeugt und Bildtexturdaten in bezug auf die erzeugten Bildflächen abbildet, um die Pixel zu erzeugen.

**17.** Gerät nach Anspruch 11, wobei die erste Speichereinrichtung (10) einen ersten und zweiten Rahmenpuffer aufweist und während eines ersten Vertikalintervalls der Bilddaten Pixel sukzessive speichert, welche durch die Bilddatenerzeugungseinrichtung erzeugt wurden, und simultan vorher erzeugte Pixel vom zweiten Rahmenpuffer liest, um ein Anzeigebild zu erzeugen, und während eines sukzessiven Vertikalintervalls der Bilddaten Daten, die durch die Bilddatenerzeugungseinrichtung im zweiten Rahmenpuffer erzeugt werden, zu -schreiben und simultan vorher erzeugt Pixel vom ersten Rahmenpuffer zu lesen, um eine zweite Bildanzeige zu erzeugen.

**18.** Gerät nach Anspruch 16, wobei die Bilddatenerzeugungseinrichtung (6) Daten, die rechteckige Bildbereiche parallel zu einer Ebene des Bilds zeigen, durch Ausführen der Sprite-Erzeugungsinstruktionen erzeugt.

**19.** Gerät nach Anspruch 18, wobei die erste Speichereinrichtung (10) die Bildtexturdaten zur Verwendung durch die Bilddatenerzeugungseinrichtung speichert.

**20.** Gerät nach Anspruch 18, wobei die erste Speichereinrichtung (10) eine Farbumsetzungstabelle speichert, die einen Code aufweist, der eine Transparenz zeigt und Daten von der Farbumsetzungstabelle zur Bilddatenerzeugungseinrichtung liest, und wobei die Bilddatenerzeugungseinrichtung (6) die Daten von der Bildumsetzungstabelle nutzt, um Farben Pixeln innerhalb der rechteckigen Bildbereiche zuzuteilen und als Antwort auf den Code, der Transparenz zeigt, vom Überschreiben von Pixeldaten als Antwort auf Lagen, die vorher in der ersten Speichereinrichtung gespeichert wurden, Abstand zu nehmen.

**21.** Gerät nach Anspruch 11, welches außerdem eine Einrichtung aufweist, um eine Sprite-Erzeugungsinstruktionsfolge von einer Anzahl der Sprite-Erzeugungsinstruktionen zu bilden, um eine Polygonerzeugungsinstruktionsfolge von einer Anzahl der zweiten Polygonerzeugungsinstruktionen zu bilden, und um eine von Sprite-Erzeugungsinstruktionsfolge und Polygonerzeugungsinstruktionsfolge in die andere von Sprite-Erzeugungsinstruktionsfolge und der Polygonerzeugungsinstruktionsfolge in einer gewünschten Lage einzufügen.

**22.** Gerät nach Anspruch 11, wobei der Sprite-Datenbereich der Sprite-Erzeugungsinstruktionen Identifikationsdaten aufweist, die zeigen, daß die Instruktion eine Sprite-Erzeugungsinstruktion ist, und der Polygondatenbereich der zweiten Polygonerzeugungsinstruktionen Identifikationsdaten aufweist, die zeigen, daß die Instruktion eine Polygonerzeugungsinstruktion ist.

**23.** Gerät nach Anspruch 11, welches außerdem eine zweite Speichereinrichtung (3) aufweist, um die Sprite-Erzeugungsinstruktionen und die zweiten Polygonerzeugungsinstruktionen zu speichern, und eine Einrichtung (7), um die in der zweiten Speichereinrichtung gespeicherten Instruktionen zur Bilddatenerzeugungseinrichtung (6) in der bestimmten Ordnung zu übertragen.

**24.** Schaltung, die aufweist:

ein Gerät nach Anspruch 11;

einen Hauptdatenbus (1);

eine Eingabeeinrichtung (5, 9), die mit dem Hauptdatenbus (1) gekoppelt ist, um die Sprite-Erzeugungsinstruktionen und die ersten Polygonerzeugungsinstruktionen zu empfangen und um die empfangenen Instruktionen dem Hauptdatenbus bereitzustellen;

einen Hauptspeicher (3), der mit dem Hauptdatenbus (1) gekoppelt ist und der davon die Sprite-Erzeugungsinstruktionen und die ersten Polygonerzeugungsinstruktionen empfängt, speichert und diese liest;

die Einrichtung (2, 8), um die zweiten Polygonerzeugungsinstruktionen zu erzeugen, die mit dem Hauptdatenbus (1) gekoppelt sind, um die ersten Polygonerzeugungsinstruktionen zu empfangen;

wobei die erste Sortiereinrichtung (2) mit dem Hauptdatenbus gekoppelt ist, um die Sprite-Erzeugungsinstruktionen und die zweiten Polygonerzeugungsinstruktionen zum Hauptspeicher zu liefern, um diese darin zu speichern;

wobei die Bilddatenerzeugungseinrichtung (6) mit dem Hauptdatenbus gekoppelt ist, und

eine Speichersteuerung (7), um die Sprite-Erzeugungsinstruktionen zur Bilddatenerzeugungseinrichtung (6) über den Hauptdatenbus (1) zu übertragen;

wobei die erste Speichereinrichtung eine Rahmenspeichereinrichtung (10) aufweist, um die Bilddaten, die durch die Bilddatenerzeugungseinrichtung (6) erzeugt werden, zu speichern.

**25.** Schaltung nach Anspruch 24, wobei die Eingabeeinrichtung (5, 9) komprimierte Bildtexturdaten empfängt und die komprimierten Bildtexturdaten zum Hauptdatenbus (1) liefert, der Hauptspeicher (3) vom Hauptdatenbus die komprimierten Bildtexturdaten empfangt, speichert und daraus liest, wobei die Schaltung außerdem einen Bilddaten-Dekomprimierer (4) aufweist, der mit dem Hauptdatenbus gekoppelt ist, um die komprimierten Bildtexturdaten, die aus dem Hauptspeicher gelesen werden, zu empfangen, wobei der Bilddaten-Dekomprimierer die komprimierten Bildtexturdaten dekomprimiert und die dekomprimierten Bildtexturdaten zum Hauptdatenbus liefert, wobei die Rahmenspeichereinrichtung (10) die dekomprimierten Bildtexturdaten in einem Texturbereich dafür speichert und die Bilddatenerzeugungseinrichtung (6) die Bilddaten erzeugt, wobei die dekomprimierten Bildtexturdaten, die in der Rahmenspeichereinrichtung gespeichert sind, verwendet werden.

**26.** Schaltung nach Anspruch 25, wobei die Eingabeeinrichtung (5, 9) einen Decoder (5) aufweist, der eine Eingabevorrichtung hat, um die komprimierten

Bildtexturdaten, die Sprite-Erzeugungsinstruktionen und die ersten Polygonerzeugungsinstruktionen in codierter Form zu empfangen und die empfangenen codierten komprimierten Bildtexturdaten, die Sprite-Erzeugungsinstruktionen und die ersten Polygonerzeugungsinstruktionen zu decodieren.

**27.** Schaltung nach Anspruch 26, wobei der Decoder (5) einen CD-ROM-Decoder aufweist und wobei die Eingabeeinrichtung außerdem eine CD-ROM-Ansteuerung (9) aufweist, um die codierten komprimierten Bildtexturdaten, die Sprite-Erzeugungsinstruktionen und die ersten Polygonerzeugungsinstruktionen davon zu lesen und diese zum CD-ROM-Decoder zu liefern.

**28.** Spielgerät zum Erzeugen von Spielabbildungsdaten entsprechend einem Spielabbild auf der Basis von Sprite-Erzeugungsinstruktionen, um zweidimensionale Bilddaten und Polygonerzeugungsinstruktionen zu erzeugen, um dreidimensionale Bilddaten zu erzeugen, wobei das Spielgerät ein Gerät gemäß einem der Ansprüche 11 bis 23 aufweist, wobei:

die Spielbenutzereingabeeinrichtung (30) Spielbetriebsbefehle als Antwort auf eine Handlung durch einen Benutzer erzeugt,
die Einrichtung (2, 8) zum Erzeugen der zweiten Polygonerzeugungsinstruktionen auf der Basis der Spielbetätigungsbefehle betreibbar ist,
die Bilddatenerzeugungseinrichtung (6) die Spielbilddaten erzeugt; und
die erste Speichereinrichtung (10) die mehreren Pixel der erzeugten Spielbilddaten speichert und die gespeicherten Pixel ausgibt, um das Spielbild zu erzeugen.

**29.** Spielgerät nach Anspruch 28, welches außerdem einen A/D-Umsetzer aufweist, um die Pixel, die durch die erste Speichereinrichtung ausgegeben werden, in eine Analogform umzusetzen.

**Revendications**

**1.** Procédé pour produire des données d'image représentant une image, le procédé comprenant les étapes de :

production (2) d'instructions de production de motif programmé représentatives de données d'image bidimensionnelles, dans lesquelles chacune desdites instructions de production de motif programmé comprend une partie de données de motif programmé (SD) et une partie d'étiquette de motif programmé (TG) représentative d'un emplacement d'adresse
production (2, 8), sur la base des premières instructions de production de polygone représentatives de données d'image tridimensionnelles, des secondes instructions de production de polygone représentatives de données d'image bidimensionnelles, chacune desdites instructions de production dudit second polygone comprenant une partie de données de polygone et une partie d'étiquette de polygone représentative d'un emplacement d'adresse ;
réalisation (2) d'une opération de tri (104), sur la base des emplacements d'adresse représentés par les parties d'étiquette des instructions de production de motif programmé et des secondes instructions de production de polygone, pour déterminer une séquence mélangée dudit motif programmé et des secondes instructions de production de polygone ladite séquence définissant un ordre pour exécuter lesdites instructions de production de motif programmé et lesdites secondes instructions de production de polygone ;
production (6) de données d'image en exécutant les instructions de production de motif programmé et les secondes instructions de production de polygone dans ledit ordre déterminé, lesdites données d'image comprenant une pluralité de pixels chacune ayant un emplacement d'image correspondant ; et
stockage (10) de la pluralité de pixels de données d'image produites dans une mémoire pour qu'un pixel produit après un autre pixel ayant un emplacement d'image correspondant, écrase l'autre pixel.

**2.** Procédé selon la revendication 1, dans lequel l'emplacement d'adresse de chacune des instructions de production de motif programmé et des secondes instructions de production de polygone représente une adresse de mémoire d'une instruction suivante des instructions à exécuter.

**3.** Procédé selon la revendication 1, dans lequel les données Z sont utilisées pour établir les emplacements d'adresse des secondes instructions de production de polygone, lesdites données Z correspondant à des profondeurs des surfaces respectives représentées par les données d'image produites.

**4.** Procédé selon la revendication 1, comprenant en outre l'étape de modification des secondes instructions de production de polygone selon le mouvement d'une image à produire avec l'utilisation des secondes instructions de production de polygone et un changement de point de vue de l'image à produire.

5. Procédé selon la revendication 4, dans lequel l'étape de modification des secondes instructions de production de polygone comprend la détermination dudit mouvement de ladite image et de ladite variation dans ledit point de vue sur la base d'une commande produite en réponse à un fonctionnement du dispositif d'entrée de jeux (30).

6. Procédé selon la revendication 1, dans lequel l'étape de production de données d'image comprend la génération des surfaces d'image et la cartographie des données de texture d'image pour des surfaces d'image générées pour produire lesdits pixels.

7. Procédé selon la revendication 6, comprenant en outre l'étape de lecture du motif programmé et des premières instructions de production de polygone à partir de la mémoire (20), de lecture des données de texture compressées à partir de la mémoire et de décompression (4) des données de texture compressées pour produire les données de texture d'image.

8. Procédé selon la revendication 7, dans lequel la mémoire (20) est sur CD-ROM.

9. Procédé selon la revendication 1, comprenant en outre les étapes de formation d'une chaîne d'instructions de production de motif programmé à partir d'un nombre desdites instructions de production de motif programmé, formation d'une chaîne d'instructions de production de polygone à partir d'un nombre desdites secondes instructions de production de polygone, et insertion de ladite chaîne d'instructions de production de motif programmé et de ladite chaîne d'instructions de production de polygone dans l'autre de ladite chaîne d'instructions de production de motif programmé et de ladite chaîne d'instructions de production de polygone à un emplacement voulu de celui-ci.

10. Procédé selon la revendication 1, dans lequel la partie de données de motif programmé de chacune des instructions de production de polygone comprend des données d'identification indiquant que l'instruction est une instruction de production de motif programmé, et la production de données de polygone de chacune des secondes instructions de production de polygone comprend des données d'identification indiquant que l'instruction est une instruction de production de polygone.

11. Appareil pour produire des données d'image représentant une image, ledit appareil comprenant :

un moyen (2) pour produire des instructions de production de motif programmé représentatives de données bidimensionnelles, où chacune desdites instructions de production de motif programmé comprend une partie de données de motif programmé (SD) et une partie d'étiquette de motif programmé (TG) représentative d'une partie d'adresse ;
un moyen (2, 8) pour produire, sur la base des premières instructions de production de polygone représentatives de données d'image tridimensionnelles, des secondes instructions de production de polygone représentatives de données d'image bidimensionnelles, chacune desdites instructions de production dudit second polygone comprenant une partie de données de polygone et une partie d'étiquette de polygone représentative d'un emplacement d'adresse ;
un moyen (2) pour réaliser une opération de tri (104), sur la base des emplacements d'adresse représentés par les parties d'étiquette des instructions de production de motif programmé et des secondes instructions de production de polygone, pour déterminer une séquence mélangée dudit motif programmé et des secondes instructions de production de polygone ladite séquence définissant un ordre pour exécuter lesdites instructions de production de motif programmé et lesdites secondes instructions de production de polygone ;
un moyen de production de données d'image (6) pour produire des données d'image en exécutant les instructions de production de motif programmé et les secondes instructions de production de polygone dans ledit ordre déterminé, lesdites données d'image comprenant une pluralité de pixels chacune ayant un emplacement d'image correspondant ; et
un premier moyen de mémoire (10) pour stocker la pluralité de pixels de données d'image produites pour qu'un pixel produit après un autre pixel ayant un emplacement d'image correspondant, écrase l'autre pixel.

12. Appareil selon la revendication 11, comprenant en outre un second moyen de mémoire (3), dans lequel l'emplacement d'adresse de chacune des instructions de production de motif programmé et des secondes instructions de production de polygone représente une adresse dans le second moyen de mémoire d'une instruction suivante des instructions à exécuter.

13. Appareil selon la revendication 12, dans lequel les données Z sont utilisées pour établir les emplacements d'adresse des secondes instructions de production de polygone, lesdites données Z correspondant à des profondeurs des surfaces respectives représentées par les données d'image produites.

**14.** Appareil selon la revendication 11, comprenant en outre un moyen de modification pour modifier les secondes instructions de production de polygone selon le mouvement d'une image à produire avec l'utilisation des secondes instructions de production de polygone et un changement de point de vue de l'image à produire.

**15.** Appareil selon la revendication 14, dans lequel le moyen de modification est fonctionnel pour déterminer ledit mouvement de ladite image et ledit changement dans ledit point de vue sur la base d'une commande produite en réponse à un fonctionnement du dispositif d'entrée de jeux (30).

**16.** Appareil selon la revendication 11, dans lequel ledit moyen de production de données d'image (6) est fonctionnel pour générer des surfaces d'image et pour cartographier des données de texture d'image pour les surfaces d'image générées pour produire lesdits pixels.

**17.** Appareil selon la revendication 11, dans lequel le premier moyen de mémoire (10) comprend des premiers et seconds tampons d'image et est fonctionnel pendant un premier intervalle vertical des données d'image pour stocker des pixels successivement produits par le moyen de production de données d'image et simultanément pour lire des pixels produits précédemment à partir du second tampon d'image pour produire une image d'affichage, et est fonctionnel pendant un intervalle vertical successif des données d'image pour écrire des données produites par le moyen de production de données d'image dans le second tampon d'image et simultanément pour lire des pixels produits précédemment à partir du premier tampon d'image pour produire un second affichage d'image.

**18.** Appareil selon la revendication 16, dans lequel le moyen de production de données d'image (6) est fonctionnel pour produire des données représentant des zones d'image rectangulaire parallèle à un plan de l'image en exécutant des instructions de production de motif programmé.

**19.** Appareil selon la revendication 18, dans lequel le premier moyen (10) est fonctionnel pour stocker les données de texture d'image pour l'utilisation par le moyen de production de données d'image.

**20.** Appareil selon la revendication 18, dans lequel le premier moyen de mémoire (10) est fonctionnel pour stocker une table de conversion de couleur comprenant un code représentant une transparence et pour lire des données à partir de la table de conversion de couleur jusqu'au moyen de production de données d'image, et dans lequel le moyen de production de données d'image (6) est fonctionnel pour utiliser des données à partir de ladite table de conversion de couleur pour assigner des couleurs aux pixels dans lesdites zones d'image rectangulaires et en réponse audit code représentant la transparence pour empêcher l'écrasement des données de pixel dans des emplacements correspondants précédemment stockés dans le premier moyen de mémoire.

**21.** Appareil selon la revendication 11, comprenant en outre un moyen pour former une chaîne d'instructions de production de motif programmé à partir d'un nombre desdites instructions de production de motif programmé, pour former une chaîne d'instructions de production de polygone à partir d'un nombre desdites secondes instructions de production de polygone, et pour insérer une de ladite chaîne d'instructions de production de motif programmé et de ladite chaîne d'instructions de production de polygone dans l'autre de ladite chaîne d'instructions de production de motif programmé et de ladite chaîne d'instructions de production de polygone à un emplacement voulu de celui-ci.

**22.** Appareil selon la revendication 11, dans lequel la partie de données motif programmé de chacune des instructions de production de motif programmé comprend des données d'identification indiquant que l'instruction est une instruction de production de motif programmé, et la partie de données de polygone de chacune des secondes instructions de production de polygone comprend des données d'indication indiquant que l'instruction est une instruction de production de polygone.

**23.** Appareil selon la revendication 11, comprenant en outre un second moyen de mémoire (3) pour stocker des instructions de production de motif programmé et les secondes instructions de production de polygone, et un moyen (7) pour transférer les instructions stockées dans le second moyen de mémoire au moyen de production de données d'image (6) dans ledit ordre déterminé.

**24.** Circuit comprenant :

un appareil selon la revendication 11 ;
un bus principal (1) ;
un moyen d'entrée (5, 9) couplé au bus principal (1) pour recevoir les instructions de production de motif programmé et les premières instructions de production de polygone et fournir les instructions reçues au bus principal ;
un moyen de mémoire (3) couplé au bus principal (1) et fonctionnel pour recevoir de celui-ci, pour stocker et pour extraire les instructions de production de motif programmé et les pre-

mières instructions de production de polygone ; ledit moyen (2, 8) pour produire les secondes instructions de production de polygone couplées au bus principal (1) pour recevoir les premières instructions de production de polygone ; ledit moyen de tri (2) étant couplé au bus principal pour fournir les instructions de production de motif programmé et les secondes instructions de production de polygone à la mémoire principale pour le stockage dans celle-ci ;
le moyen de production de données d'image (6) étant couplé au bus principal ; et
un dispositif de commande de mémoire (7) pour transférer les instructions de production de motif programmé au moyen de production de données d'image (6) via le bus principal (1) ; ledit premier moyen de mémoire comprenant un moyen de mémoire de trame (10) pour stocker les données d'image produites par le moyen de production de données d'image (6).

**25.** Circuit selon la revendication 24, dans lequel le moyen d'entrée (5, 9) est fonctionnel pour recevoir des données de texture d'image compressées et pour fournir les données de texture compressées au bus principal (1), la mémoire principale (3) est fonctionnelle pour recevoir du bus principal, pour stocker et pour extraire les données de texture d'image compressées, le circuit comprend en outre un décompresseur de données d'image (4) couplé au bus principal pour recevoir les données de texture d'image compressées, extraites de la mémoire principale, le décompresseur de données d'image étant fonctionnel pour décompresser les données de texture d'image compressées et pour fournir les données de texture d'image décompressées au bus principal, le moyen de mémoire de trame (10) est fonctionnel pour stocker les données de texture d'image décompressées dans une zone de texture de celui-ci, et le moyen de production de données d'image (6) est fonctionnel pour produire les données d'image utilisant les données de texture d'image décompressées stockées dans le moyen de mémoire d'image.

**26.** Circuit selon la revendication 25, dans lequel le moyen d'entrée (5, 9) comprend un décodeur (5) ayant une entrée pour recevoir les données de texture d'image compressées, les instructions de production de motif programmé et les premières instructions de production de polygone dans une forme codée et fonctionnel pour décoder les données de texture d'image compressées codées reçues, les instructions de production de motif programmé et les premières instructions de production de polygone.

**27.** Circuit selon la revendication 26, dans lequel le décodeur (5) comprend un décodeur de CD-ROM, et dans lequel le moyen d'entrée comprend en outre un lecteur de CD-ROM (9) pour lire les données de texture d'image compressées codées, des instructions de production de motif programmé et des premières instructions de production de polygone à partir de celui-ci et pour fournir celles-ci au décodeur de CD-ROM.

**28.** Console de jeux pour produire des données d'image de jeux représentant une image de jeu sur la base des instructions de production de motif programmé pour produire des données d'image bidimensionnelles et des instructions de production de polygone pour produire des données d'image tridimensionnelles, la console de jeux comprenant un appareil selon l'une quelconque des revendications 11 à 23, dans lequel :
un moyen d'entrée d'utilisateur de jeux (30) est utilisable pour produire des commandes de fonctionnement de jeux en réponse à une action par un utilisateur ;
ledit moyen (2, 8) pour produire les secondes instructions de production de polygone est utilisable sur la base des commandes d'opération de jeux ;
ledit moyen de production de données d'image (6) est utilisable pour produire des données d'image de jeux ; et
ledit premier moyen de mémoire (10) est utilisable pour stocker la pluralité de pixels des données d'image de jeux produites et pour fournir les pixels stockés pour produire l'image de jeu.

**29.** Console de jeux selon la revendication 28, comprenant en outre un convertisseur A/N pour convertir les pixels fournis par le premier moyen de mémoire sous forme analogique.

FIG. 1

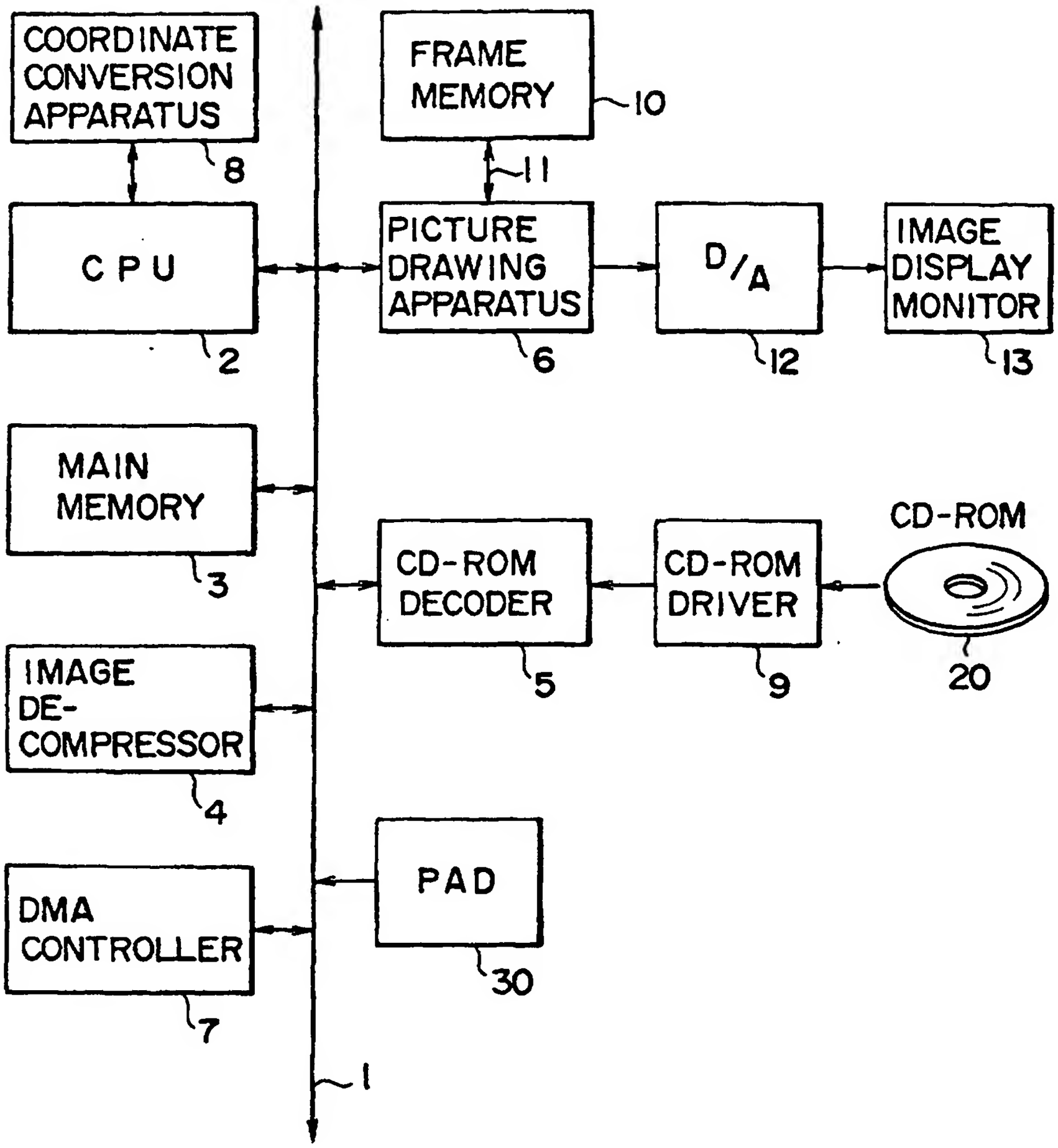
COORDINATE CONVERSION APPARATUS
8
FRAME MEMORY
10
11
CPU
2
PICTURE DRAWING APPARATUS
6
D/A
12
IMAGE DISPLAY MONITOR
13
MAIN MEMORY
3
CD-ROM DECODER
5
CD-ROM DRIVER
9
CD-ROM
20
IMAGE DE-COMPRESSOR
4
DMA CONTROLLER
7
PAD
30
1

FIG. 2

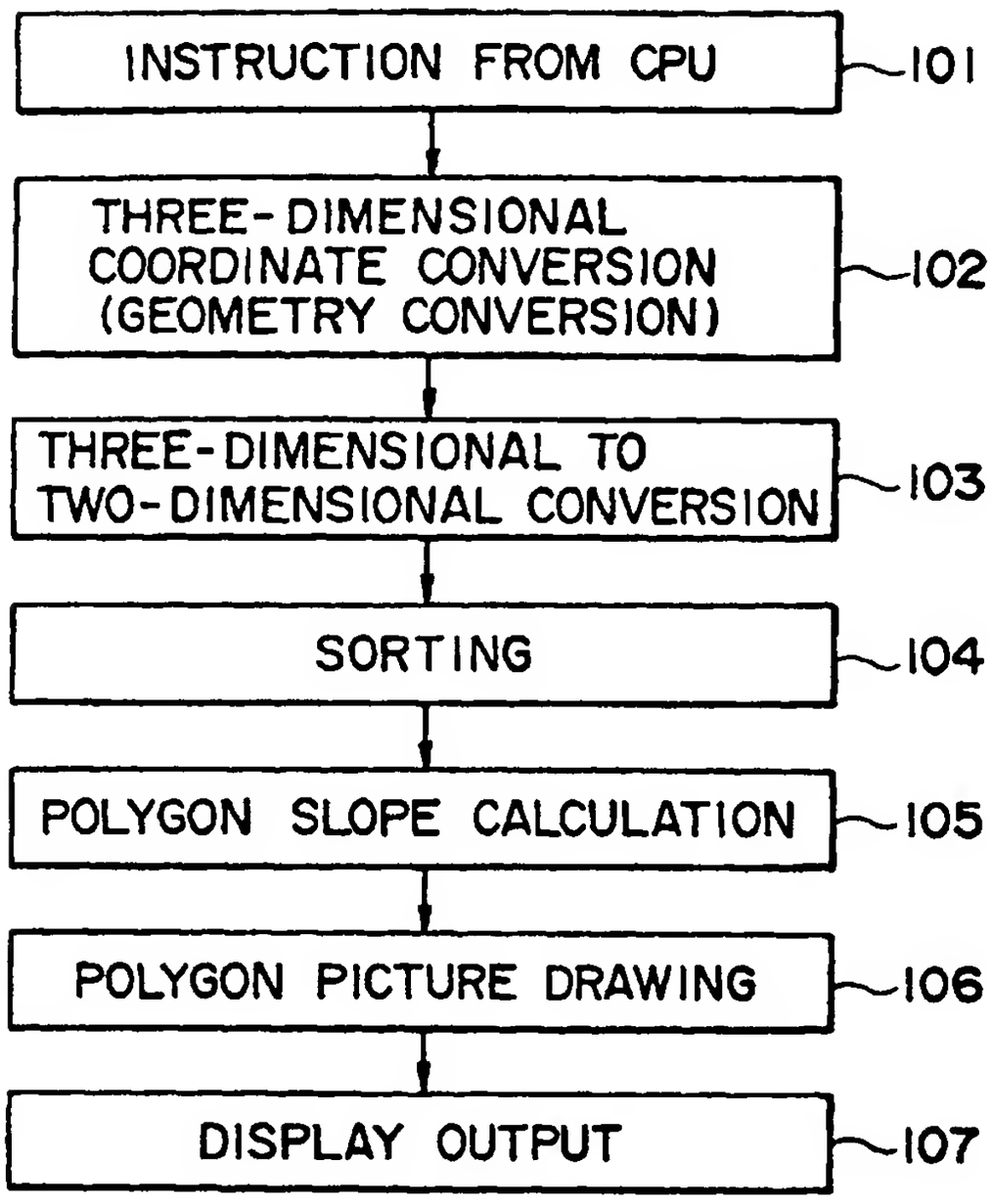
INSTRUCTION FROM CPU
101
THREE-DIMENSIONAL COORDINATE CONVERSION (GEOMETRY CONVERSION)
102
THREE-DIMENSIONAL TO TWO-DIMENSIONAL CONVERSION
103
SORTING
104
POLYGON SLOPE CALCULATION
105
POLYGON PICTURE DRAWING
106
DISPLAY OUTPUT
107

FIG. 3

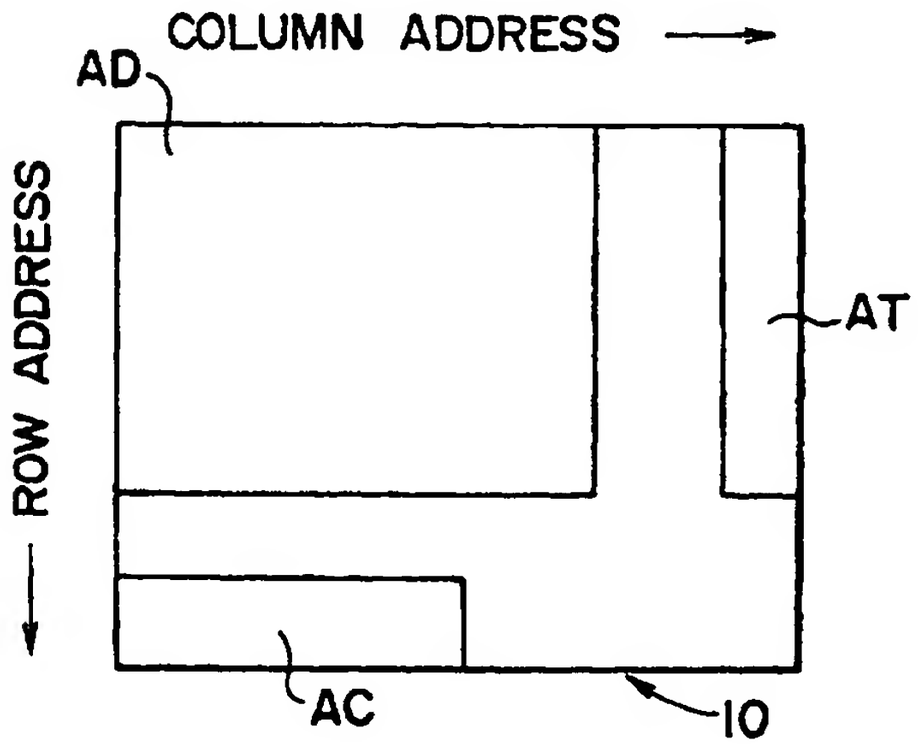
COLUMN ADDRESS
AD
ROW ADDRESS
AT
AC
IO

FIG. 4C

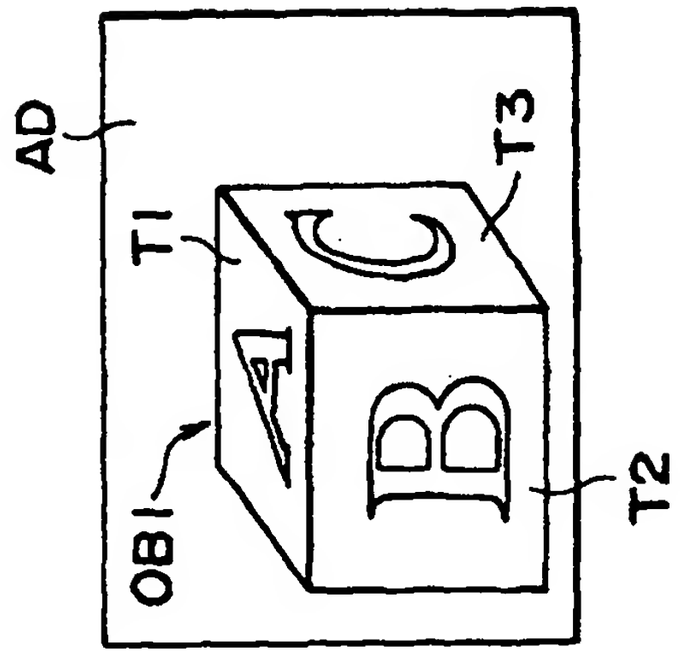


FIG. 4B

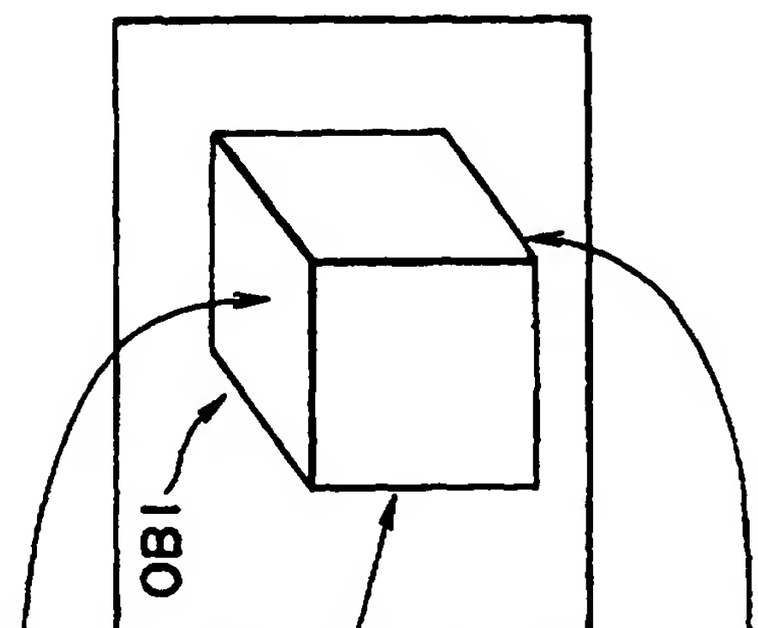


FIG. 4A

FIG. 5A

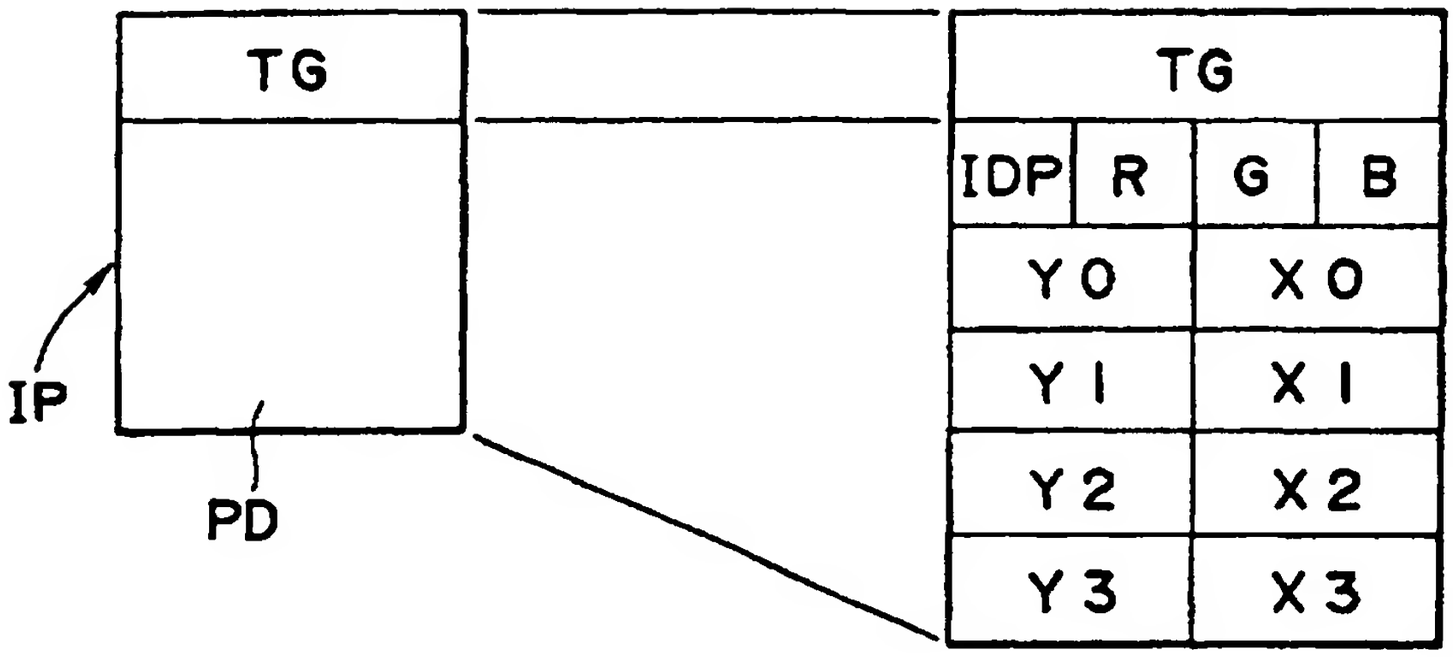


FIG. 5B

| TG | | | |
|---|---|---|---|
| IDP | R | G | B |
| Y 0 | | X 0 | |
| Y 1 | | X 1 | |
| Y 2 | | X 2 | |
| Y 3 | | X 3 | |

FIG. 6

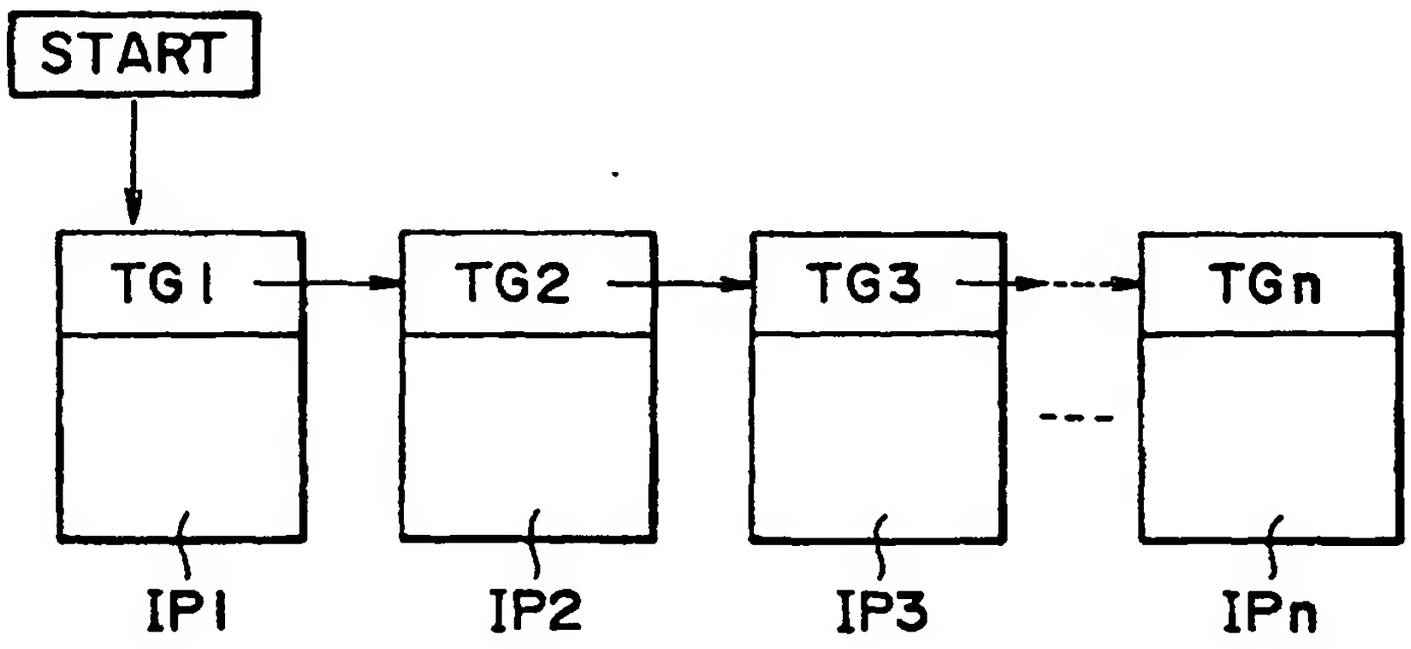

FIG. 7

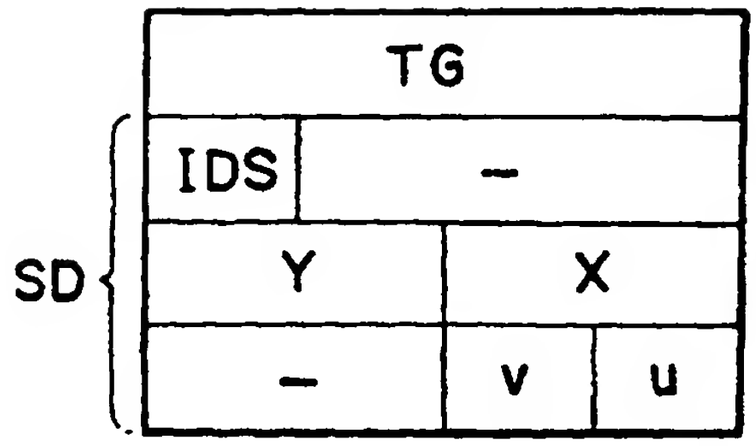


FIG. 8

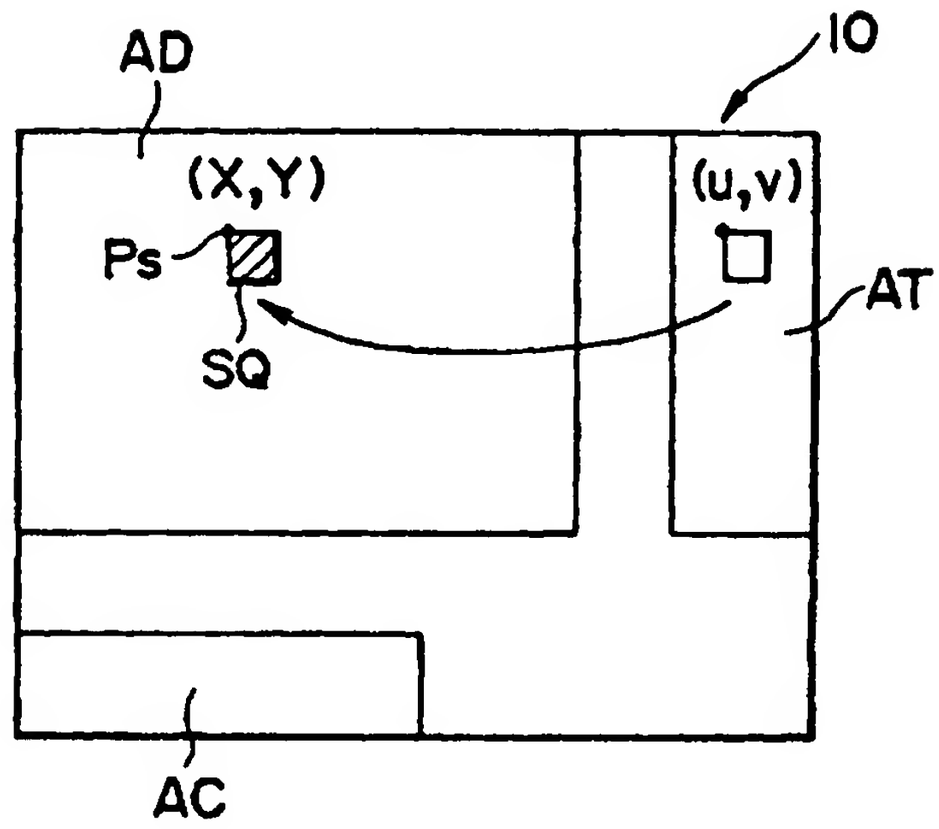

FIG. 9

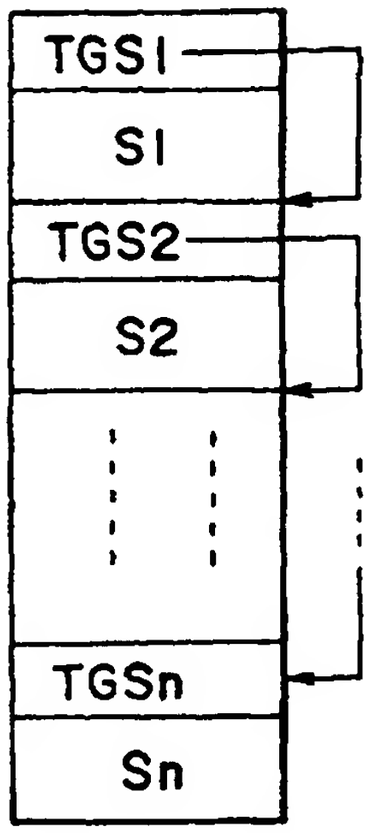


FIG. 10A

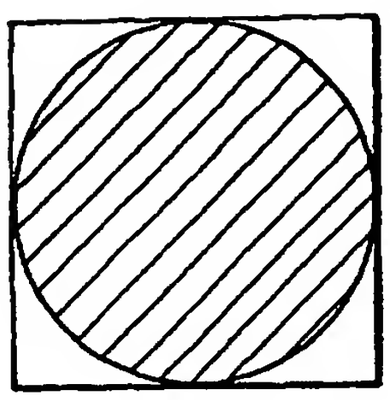

FIG. 10B

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 2 | 2 | 1 | 0 |
| 1 | 1 | 1 | 2 | 3 | 2 | 1 | 1 |
| 1 | 1 | 2 | 3 | 3 | 2 | 1 | 1 |
| 0 | 1 | 2 | 2 | 2 | 2 | 1 | 0 |
| 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |

FIG. 11

COLOR INDEX ← NUMBER

| | R | G | B |
|---|---|---|---|
| 0 | r1 | g1 | b1 |
| 1 | r2 | g2 | b2 |
| 2 | r3 | g3 | b3 |
| : | : | : | : |
| : | : | : | : |
| : | : | : | : |
| : | : | : | : |

CLUT
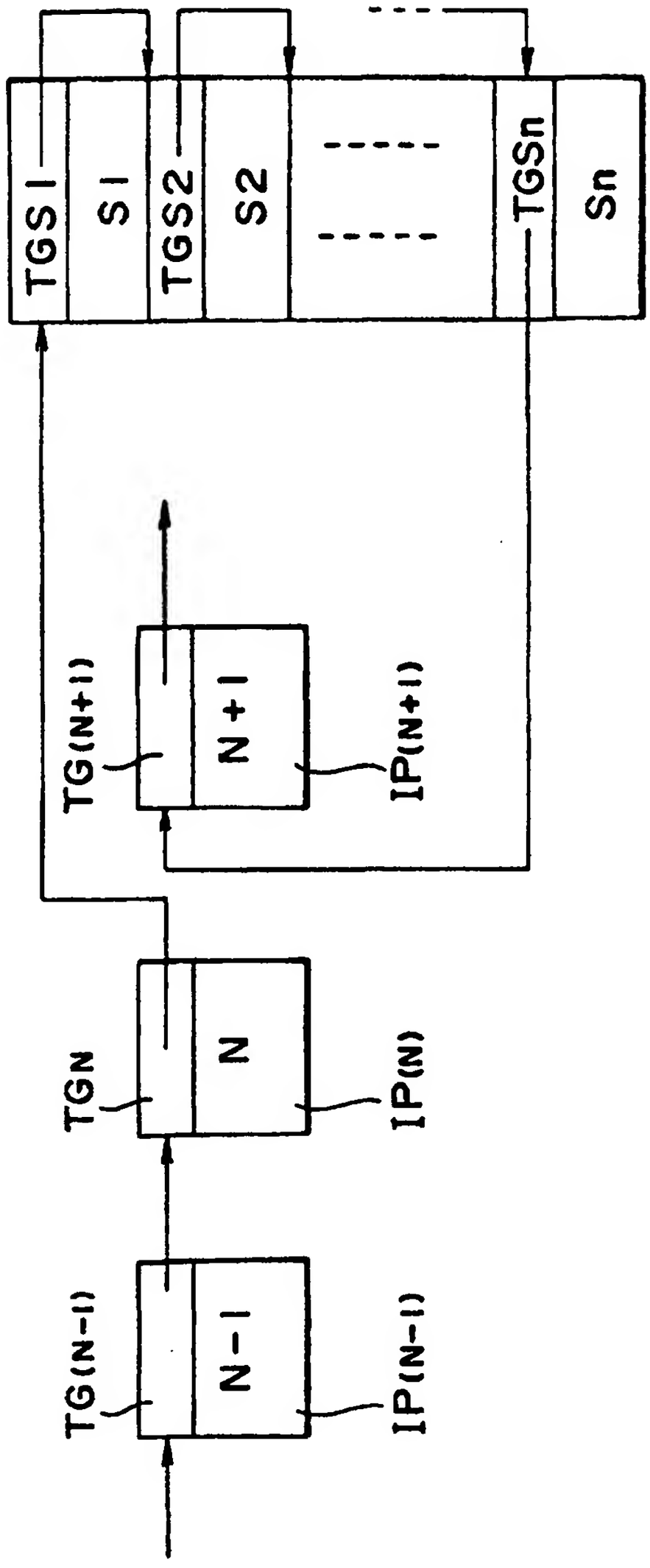
FIG. 12